Space Weather Technical Forecast

Issued on Sunday, 22 September 2024 at 01:17 Local

From the 24th of September, the way we distribute this forecast is changing and you will need to take action to continue receiving it. You should have received an email on the 4th of September explaining the steps required to do this. If you have already signed up to receive the forecast on our premium website, please disregard this message. If you haven't, or if you need help with the process, please contact moswoc@metoffice.gov.uk

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of M-flares (R1-R2 Blackouts). Chance of Active to G1/Minor Geomagnetic Storm intervals 24-25 Sep.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Low with occasional C-class flares and a peak C4.4 at 21/2046 UTC from AR3831 west of the north-centre disc. There are currently eight sunspot regions on the disc. AR3828, in the southeast remains the largest region on the disc. The most notable regions, however, are AR3831 and nearby AR3833, both in the northwest. Although AR3831 largely consists of two main spots, there remains a weak delta spot on the leader. AR3833 continues to elongate with new regions having rapidly emerged and matured sufficiently for the region to now be classified as Dai/Beta-Gamma. AR3825 in the southwest disc continues to decline. The other regions are either small, simple or both.

No Earth-directed CMEs were observed. However, a filament disruption and lift-off from the southern disc around 21/1930UTC may have produced a small CME and awaits LASCO imagery for confirmation.

Solar Wind / Geomagnetic Activity: Solar wind speeds, as observed by ACE at L1, eased around 21/0900 UTC from Slightly Elevated to be at background, from 420 km/s to near 350km/s. Winds then saw a slight uptick around 21/1800 UTC returning to Slightly Elevated levels and are currently around 400-420 km/s. Density was below average. The Interplanetary Magnetic Field, Bt, was weak throughout at 2-7nT, with north-south component, Bz, fluctuating weakly between +7nT and -6nT. Phi angle was initially positive (away from the Sun), but switched to negative (towards the Sun) at around 21/0800 UTC where it has now largely remained. Geomagnetic activity was Quiet (Kp 1-2).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 was at Background. High energy electron flux (greater than 2MeV) observed by GOES16 was mainly Moderate but rose be High in the period between 21/1640-1730 UTC and has been at High levels since 21/1850 UTC, although is trending towards Moderate at time of writing. Peak of 1590 pfu at 21/2045 UTC. The associated 24-hour fluence remained below Active but showed a flat trend, with the 22/0000UTC observation 6.05e7 total pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is expected, with a chance of isolated M-class flares. At least one new or returning region is expected to rotate onto the disc by Day 2 (23 Sep).

Solar Wind / Geomagnetic Activity: No Earth-directed CMEs currently feature in the forecast. Some slight enhancement to wind speeds is possible on Day 1 (22 Sep) should connection to the narrow CH71/+ occur. Otherwise winds are expected to decline to background levels.

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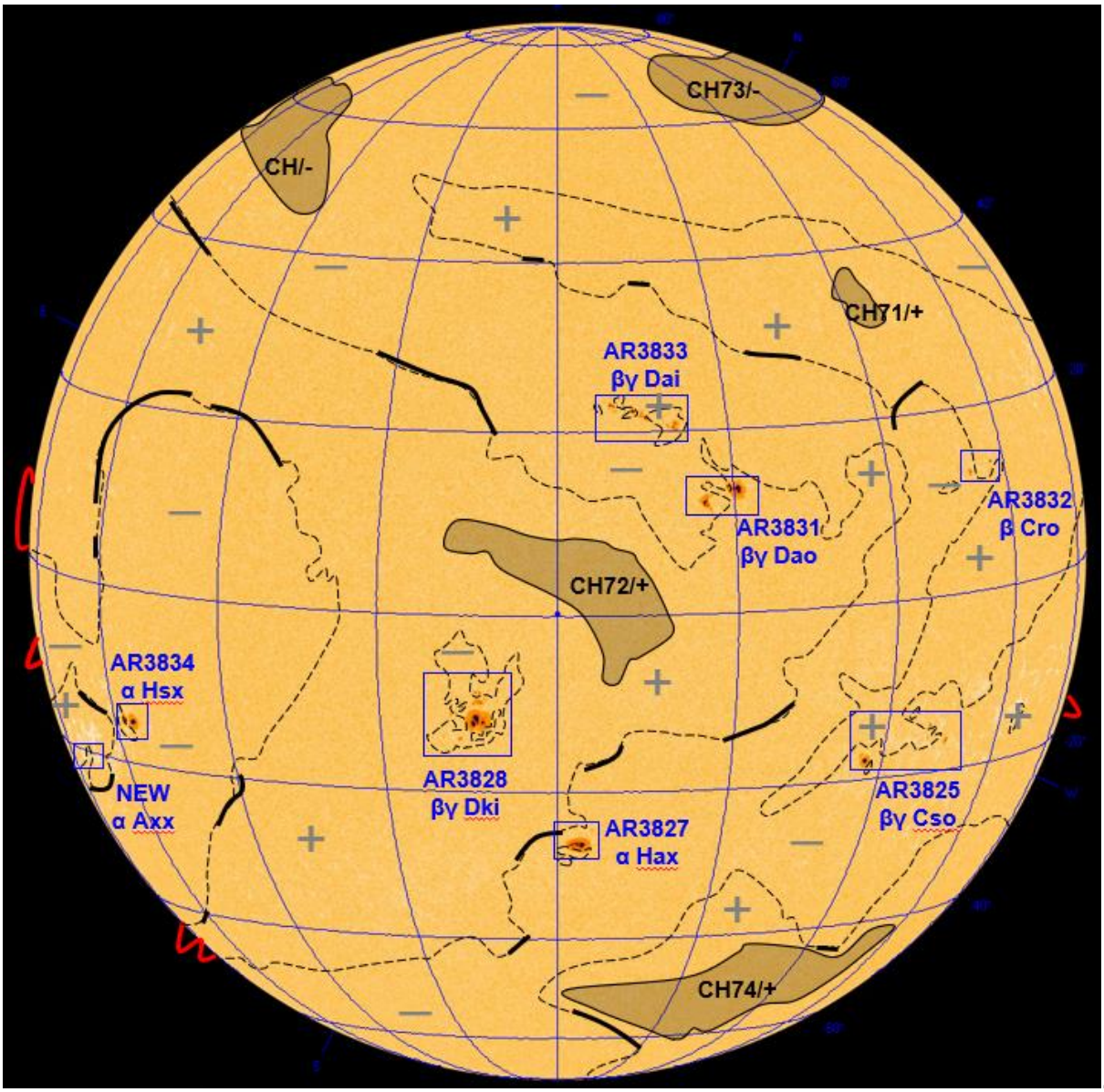
Further enhancement then expected from late on Day 3 (24 Sep) from a HSS from CH72/+ with a chance of wind speeds increasing to around 500 km/s.

Mainly Quiet activity forecast (Kp 0-2) with isolated Unsettled (Kp 3) intervals. Any onset of the fast winds towards the end of Day 3 and during Day 4 (25 Sep) will bring the chance of Active (Kp 4) intervals and a chance of G1/Minor Geomagnetic Storm intervals (Kp 5).

Energetic Particles / Solar Radiation: High energy proton flux at GOES18 is expected to remain at Background. High energy electron flux is forecast to be Moderate with diurnal peaks at High. Solar wind interactions later Day 3 and during Day 4 may act to suppress the observed electron flux values towards background. There is only a slight chance of the associated 24 hour fluence breaching the Active threshold, mainly during Days 1-2 (22-23 Sep).

Figure 1. Solar Analysis Valid 21/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are currently no Earth-directed CMEs.

At the start of the period solar winds are expected to be mainly at, or close to, background levels. While now considered unlikely, there remains the small chance of a weak enhancement during Day 1 (22 Sep) from the small northern coronal hole CH71/+. Confidence is very low due to its small size and northern position, however, given the proximity to the September equinox, the positive polarity of the coronal hole increases the potential of some slightly increased geomagnetic activity should a connection occur.

Connection to a HSS from CH72/+, currently central disc, is anticipated later Day 3 (24 Sep), or more likely, on Day 4 (25 Sep). This coronal hole is a persistent feature and is in a generally similar location when compared to the previous rotation, but appears stronger and extends slightly further west on this occasion. These characteristics, along with the coronal holes positive polarity would suggest an earlier connection, a stronger response and greater possibility of geomagnetic enhancement. MOSWOC Enlil suggests a slight rise in winds towards the end of the period, but is considered to be too low with forecast values, perhaps seeing speeds around 500 km/s Some of Enlil's ensemble members suggest a connection to the HSS may begin earlier on Day 3, which is considered low confidence at this stage.

Geomagnetic activity is forecast to be mainly Quiet (Kp 0-2) with isolated Unsettled (Kp 3) intervals. The anticipated onset of CH72/+ will bring a chance of Active intervals and of isolated G1/Minor Geomagnetic Storm intervals later Day 3 into Day 4 (24-25 Sep).

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	5	5	20	30
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

No Earth-directed CMEs currently feature in the forecast.

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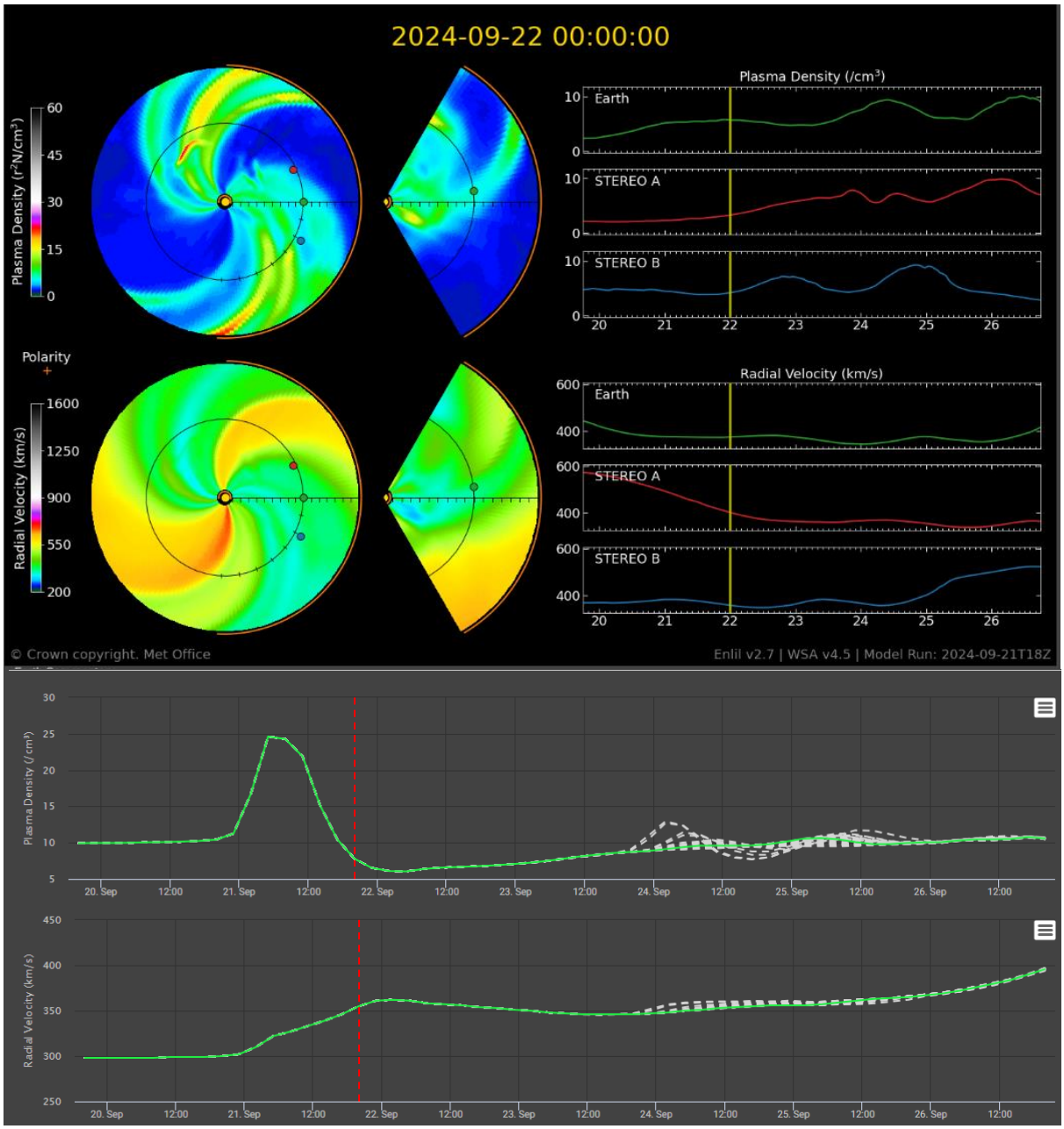
Figure 2: MOSWOC Enlil and Ensemble members. Providing reasonable steer, but wind speeds considered too low following connection to CH72/+ 24-25 Sep.



Radio Blackouts - X-Ray Flares:

Low to Moderate activity is expected. There are currently around eight sunspot regions on the visible disc, one of which is unnumbered. The most notable region is AR3831 (Dao/Beta-Gamma-Delta) in the northwest. While this largely consists of just the two main spots, each of these also has a small reverse polarity spot to its north. The one to the north of the positive leader, is responsible for the region's delta configuration. AR3833 (Dai/Beta-Gamma), in close proximity to AR3831, shows flux emergence towards its trailing portion. This region continues to lengthen and develop in complexity, but currently remains a relatively small region. AR3828 (Dki/Beta-Gamma), in the southeast, is the largest region on the disc and consists of a number of smaller spots centred around one much larger spot.

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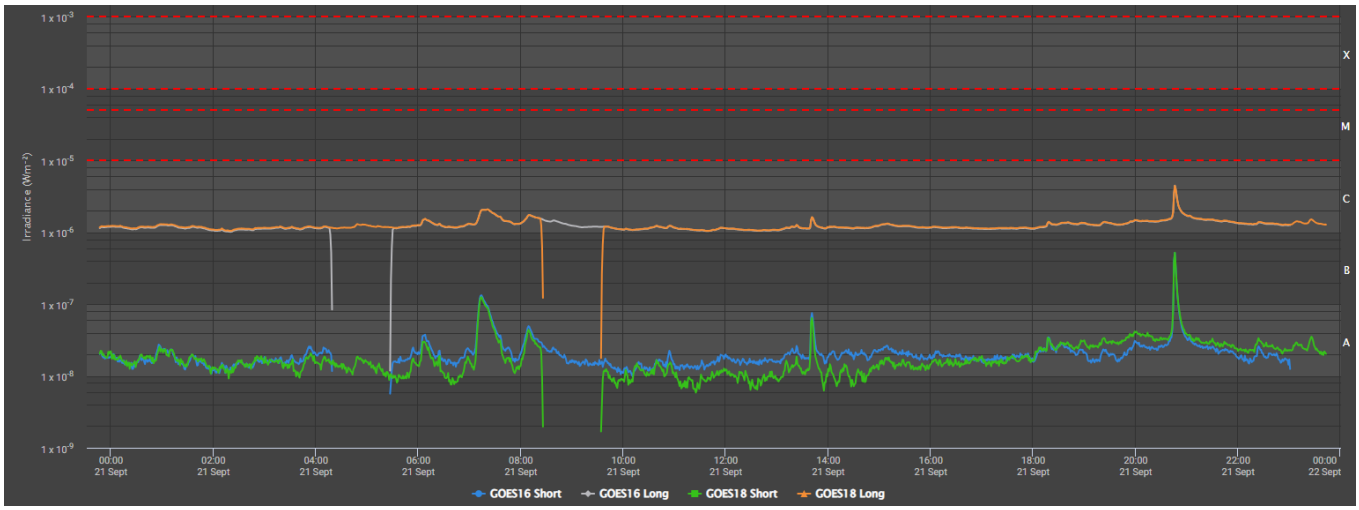
AR3825 (Cso/Beta-Gamma), in the southwest, the source of the notable X4.5 flare on 14 Sep, generally continues to decay and is not expected to produce any further significant flares. The other regions are smaller, simpler and stable.

Some notable magnetic looping remains evident in SDO/AIA-171 from Ex-AR3824 just over the southwest limb, although this has now largely rotated out of view onto the far-side. Any large flares from this region may still be visible early on Day 1 (22 Sep). Of greater significance perhaps, is the magnetic looping apparent on SDO SDO/AIA-171 and areas of brightness close to the eastern limb on SDO/AIA-0094. This, along with far-sided helioseismology, suggests the return of at least one region by Day 2 (23 Sep) and further large or strong regions during the forecast period. Due to uncertainty about the nature of these regions and their potential for producing notable flares, a slight increase in flare probabilities has been catered for on Day 4 (25 Sep).

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**R1-R2 M Class**	No	40	40	40	50
Very Active	**R3 to R5 X Class**	No	5	5	5	5

Figure 3: GOES16 and GOES18 X-Ray Irradiance over the past 24 hours showing continued Low activity.



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Solar Radiation Storms - (High Energy Protons):
High energy proton flux at GOES18 is at background levels. AR3825 in the southwest, was previously the source of an X-class flare and cause of the S1/Minor Radiation storm on 17 Sep. However, this region has now simplified, reducing the probability for notable flares from this source during the period. AR3828 in the southeast, along with AR3831 and AR3833 in the northwest, have the potential to produce notable flares and will be monitored as they move into a more favourable position for producing a response at Earth. As a result, flare probabilities have been maintained at a very slight chance.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy flux, as observed by GOES-16 at GEO has been Moderate to High. This is due to the background to slightly elevated solar winds allowing the recent lower orbital level charging, from the CME arrival overnight on 16-17 Sep, to expand outward. While no further notable solar wind enhancements are forecast in the short-term, an overall declining trend is now likely due to natural decay, with flux seeing reduced periods of High and perhaps easing to Background around diurnal minima by Day 2 (23 Sep). Any fast wind onset from CH72/+ later on Day 3 (24 Sep) or during Day 4 (25 Sep) will also help to drop out any remaining flux with flux values expected to fall to Background.

The associated 24 hour fluence currently remains below the Active threshold, but still retains the potential to rise a little further given the protracted period of High flux during the UTC evening of 21 Sep. However, on the whole fluence values appear to have plateaued, and is considered more likely to remain below the Active level. MOSWOC REFM continues to underestimate the current fluence but does suggest a steeply declining trend through the outlook period, supporting a much reduced likelihood of now reaching the Active level.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	15	10	5	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: GOES16 Electron Flux showing periods of High flux over the past 24 hours.

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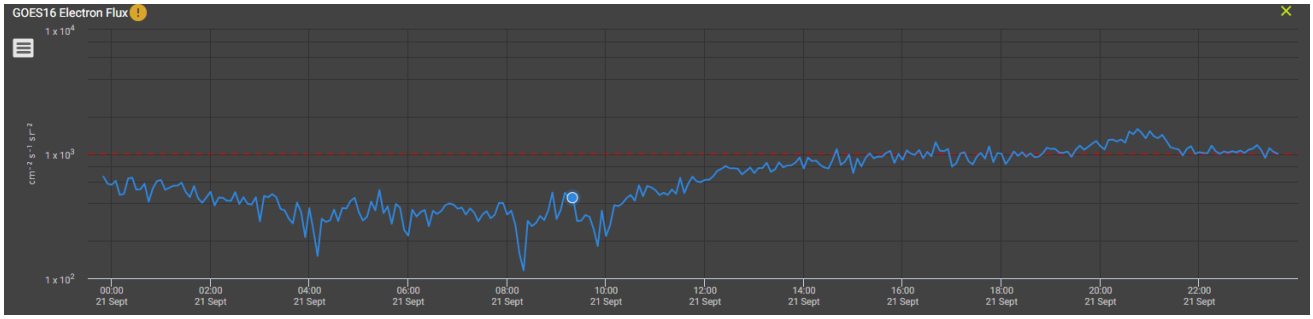
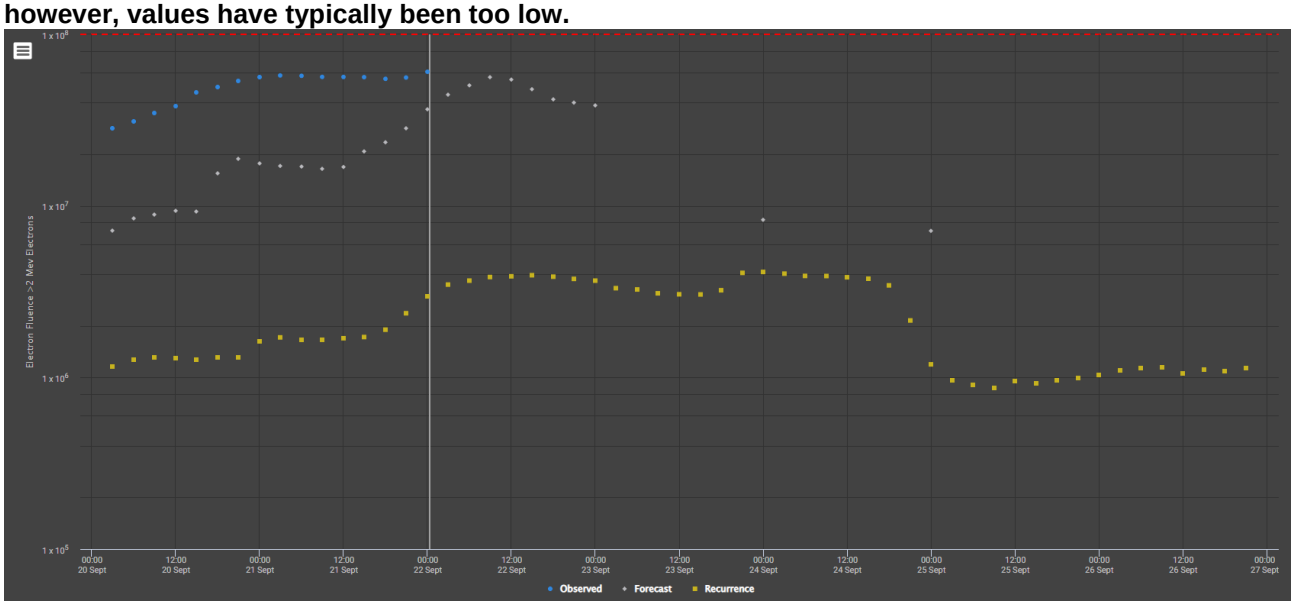


Figure 5: MOSWOC REFM. Considered to be giving reasonable guidance with the forecast trend, however, values have typically been too low.



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